SIS Receiver for THz Radioastronomy

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The SIS receiver technology is a relatively new approach to the problems of the molecular spectroscopy in a far-infrared part of the electromagnetic spectrum. Until the development of the NbTiN-based SIS devices, other technologies (e.g., such as Hot Electron Bolometer or Schottky mixers) were considered as a sole competitive approach to heterodyne spectroscopy in the 1–2 THz band. We developed a 1.1–1.25 THz SIS mixer for the Herschel Space Observatory HIFI instrument. The minimum DSB SIS receiver noise is 6 hv/k, apparently for the first time in the far-infrared band. The local oscillator (LO) power used for frequency mixing is only 100 nW. The combination of a low noise and a low LO power requirement makes the SIS receiver a potential component for a space radio observatory. The developed SIS mixer has a quasi-optical design, with a double slot planar antenna and a Si hyper-hemispherical lens. The SIS junctions are Nb/AlN/NbTiN with a critical current density of about 40 KA/cm^2 and with a junction area of about a quarter of a micron square. For ease of the Josephson current suppression, the SIS junctions are diamond-shaped. The simultaneous suppression of the Josephson currents in the two SIS junctions is a particular advantage of the shape used . In the mixer circuit a low loss Nb/Au micro-strip transmission line is used. The achieved mixer IF band is 4–8 GHz, and it may be extended. The minimum uncorrected Double Sideband receiver noise is 550 K. The minimum receiver noise, corrected for the local oscillator beam splitter and for the cryostat window, is 330 K. This type of receiver may be useful for observations with single aperture instruments and for radio interferometers in space. We will discuss the prospect of SIS receiver use at the 1–2 THz frequencies.

From Spitzer to Herschel and Beyond Pasadena, California, June 2004 Conference Program and Abstracts